

Decomposing GHG Emissions in the Textile Industry: Sectoral, Material, and Decoupling Analysis (2019–2024)

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ABSTRACT

The textile sector is a significant producer of greenhouse gases (GHG) and has been increasingly under scrutiny for its environmental sustainability due to climate change and increasing resource consumption. This study aims to provide an overview of the evolution and drivers of GHG emissions in the textile sector in 2019-2024, focusing on apparel and household textiles and the level of economic–environmental decoupling. The study analyses sectoral-level information on achievements of textile production and GHG emissions in 2019-2024 and applies regression analysis to estimate the relationship between production and GHG emissions across sectors of total textiles, apparel and household textiles. Also, the patterns of decoupling and carbon intensity are examined to analyse the variation in environmental efficiency over the study period. Overall textile output grew by some 15.5% while GHG emissions grew by 17.7%, suggesting that emissions rose at a higher rate than output. Carbon intensity changed very little, rising slightly from 2.00 to 2.04, which gives some weak evidence of relative decoupling. Apparel made up about 68% of total textile emissions, and household textiles contributed about 29%. Emissions were positively and significantly correlated with production, with elasticities of 1.33 for total textiles, 1.19 for apparel, and 1.08 for household textiles, suggesting that emissions rose faster than production. The year variable was not significant, indicating that the effects of technological or policy changes were not significant independently. In general, the present research results suggest that there is no evidence of absolute decoupling, and there is only weak relative decoupling in the textile industry. This means that uptake of renewable energy, cleaner production technologies, process efficiency, and low-impact materials will be key to ensure continued growth in the textile sector is coupled with climate goals.

Keywords: Textiles, emissions, carbon, GHG, environment

1. Introduction

1.1. General Background

Climate change is defined as the long-term change in weather and temperature patterns, caused by natural shifts and, since the 1800s, primarily by anthropogenic human activities (United Nations, n.d.). The decade from 2015-2024 was the warmest on record, as the average temperature of Earth's surface is approximately 1.44°C warmer than at any time in the last 100,000 years (United Nations, n.d.). Climate scientists state that climate change has been driven primarily by greenhouse gas (GHG) emissions, including carbon dioxide, methane, and nitrous oxide (Bhatti et al., 2023). It has been predicted that by 2100, GHG emissions would rise in all G7 countries except the UK. The UK and Japan are attempting to adopt renewable energy measures to reduce GHG emissions, but the US and Canada are struggling to reduce their fossil fuel dependency. The repercussions of climate change are dire and extend far beyond extreme environmental degradation to the economy as well, including supply chain disruptions, adaptation costs, productivity losses, and market instability (Baker Tilly International, 2026). That established, it is extremely vital to ensure sustainable production systems to achieve climate targets and decouple growth from emissions.

The textile industry includes research, design, development, manufacturing, and distribution of textiles, fabrics, and clothing (Acme Mills, 2026). This industry is one of the largest and most globalised industries in the world and is a crucial sector of the economy by supplying apparel, providing employment to many, and contributing significantly to the GDP, but has now been criticised for its massive environmental footprint due to excessive energy and resource consumption. It has now been found that the textile industry produces 2-8% of global GHG emissions and uses "86 million Olympic-sized swimming pools worth of water a year" (United Nations Environment Programme [UNEP], 2023). Resource-intensive production processes in the textile industry, including fibre cultivation, weaving, dyeing, and garment manufacturing, require substantial amounts of electricity, water, and other natural resources. With annual carbon dioxide emissions of 4 billion tonnes, the need for sustainable practices is extremely important (Assuncao, 2026).

The textile industry is divided into sub-sectors, primarily the apparel sector and the home textiles sector, which differ significantly in production dynamics and emission characteristics (Bajaj Finance, n.d.). The apparel sector entails processes such as material production and extraction (including polyester production), energy-intensive fabric processing, garment manufacturing/distribution using cutting and sewing, extensive global shipping, and consumer use/end-of-life items (Rawshot.ai, 2026). This sector is characterised by continuously changing fast-fashion trends and high production volumes that lead to significant resource utilisation and

depletion of natural resources. On the other hand, the home textile sector includes products like bedding, curtains, carpets, and upholstery that typically have a longer life span and a more stable demand pattern compared to apparel (*Buy Home Furnishing and Home Textile at IKEA*, n.d.). Due to these differences in production and consumption behaviours, the two textile sectors vary in terms of emissions. The production of apparel drives higher emissions due to frequent manufacturing cycles, transportation, and disposal, while home textiles are often associated with emissions from material-intensive manufacturing processes (Business for Social Responsibility [BSR], 2009). Furthermore, sector-wise analysis is necessary to identify specific emission-driving factors and design mitigation strategies accordingly. This would also provide better and more accurate judgements of the textile industry's environmental performance and support the development of effective decarbonization policies (Filho et al., 2024).

A major component of GHG emissions within the textile industry is material composition, as various types of fibres have different water, energy, land, and chemical input requirements during production. Synthetic fibres, including polyester, nylon, and acrylic, are obtained from fossil fuels and typically utilise energy-intensive production processes and trade dependency; therefore greater carbon footprint (GeeksforGeeks, 2024; Sovbetov, 2025)). These fibres monopolise the global market, making up 67% of total fibre production as of 2023, with polyester alone comprising 57%, exhibiting its high contribution to industry emissions (Textile Exchange, 2024). On the contrary, plant-based fibres like linen and cotton are renewable and sustainable alternatives to synthetic fibres due to lower energy consumption, elucidating a 40% reduction in global warming potential; however, certain fibres like cotton can also pose a few environmental challenges due to reliance on irrigation, fertiliser use, and land cultivation (fabric fabric, n.d.; Al-Maharma et al., 2022). Animal-based fabrics are those that are obtained from animals, primarily sheep, goats, and silkworms and are used in winter clothing; examples include wool and silk, which are associated with methane emissions, land use, and livestock-related environmental burdens (Jiménez et al., 2024). Cellulose-based fibres, including viscose, modal, and lyocell, occupy an intermediate position, as their sustainability largely depends on specific sourcing and processing technologies (Stewart, 2025).

While the environmental burdens of the textile industry are well-established, the economic growth it provides certainly offsets some burden, creating a trade-off between the two. The textile industry provides employment and incorporates various aspects of the economy, including agriculture, manufacturing, and retail, supports local artisans and exports in the economy (Sancheti, 2025). Decoupling theory assesses this contemplation between economic growth and sustainability by proposing that economic growth can happen without environmental degradation through the adoption of natural resources, cleaner production processes, technological innovation, and efficiency (UNEP, 2011). Decoupling is traditionally classified into relative

decoupling, where environmental burdens such as carbon emissions increase but at a slower rate than economic output, and absolute decoupling, where economic growth is achieved while emissions decline in absolute scale. Relative Decoupling highlights improvements in productive efficiency, and absolute decoupling is consistent with long-term climate mitigation roles (European Environment Agency (EEA), n.d.). Carbon intensity, which is the GHG emissions per unit of economic output or industrial value added, serves as a key indicator of environmental efficiency, measuring how effectively an industry generates economic value while minimizing emissions. Declining carbon intensity signifies technological advancement, energy efficiency improvements, and successful adoption of low-carbon production practices, making it an essential metric for evaluating the sustainability performance of the textile sector (UNEP, 2011).

1.2. Literature review

The textile industry has a complex and energy-intensive value chain in which greenhouse-gas emissions vary according to production stage, material type, energy source, and system boundary. Therefore, understanding textile emissions requires more than measuring total sectoral output; it also requires examining how different fibers and manufacturing processes contribute to overall carbon intensity. Existing research has largely focused on product-level footprints, material comparisons, energy consumption, and the relationship between economic growth and emissions. Together, these studies provide the conceptual and methodological foundation for analyzing sectoral, material, and decoupling trends from 2019 to 2024.

Imran et al. (2023) developed a bottom-up framework to calculate textile products' carbon, energy, and water footprints. Their assessment covered direct and indirect emissions across production stages and reported a total carbon footprint of 42,624.12 MT CO_{2e}, an energy footprint of 248.38 PJ, and a water footprint of 80.71 billion liters. Spinning was identified as a major contributor, while energy consumption was the principal driver of all three footprints. These findings establish the importance of analyzing emissions by production stage and provide a useful baseline for comparing emissions across textile materials and sectors. Building on the importance of energy use, Wang et al. (2017) examined China's textile industry from 1991 to 2015 using energy-footprint assessment, decoupling analysis, and the Logarithmic Mean Divisia Index (LMDI). The industry's energy footprint increased from 41.1 Mt to 99.6 Mt. Their analysis emphasized the roles of industrial scale, energy efficiency, energy mix, and structural change. This approach is relevant to the present study because it demonstrates how decomposition methods can distinguish the effects of production growth from changes in energy performance.

Hong et al. (2025) applied similar concepts to carbon emissions and economic growth in China's textile industry across 30 provinces from 2001 to 2020. Using the Tapio decoupling model and LMDI, the authors found that emissions and GDP followed a "rise then decline" pattern. Coal

remained the principal emissions source, although its share declined as natural-gas use increased. China's textile industry achieved strong decoupling overall: per-capita output increased emissions, whereas declining energy-consumption intensity reduced them. These findings directly support the proposed assessment of whether textile-production growth between 2019 and 2024 was accompanied by proportional emissions growth or by declining carbon intensity. Material composition provides another important explanation for differences in textile emissions. Filho et al. (2024) reviewed the environmental impacts of clothing, footwear, and household textiles and concluded that carbon footprints vary according to fiber type and production method. Their findings suggest that cotton, wool, and silk generally have lower carbon footprints than polyester and nylon, while closed-loop systems and sustainable production methods perform better than conventional processes. This comparison supports the proposed classification of synthetic, plant-based, animal-based, and cellulose-based materials.

However, material comparisons must be interpreted alongside process and energy conditions. Sharma et al. (2017) investigated solar industrial process heating in India's cotton-textile industry and estimated that renewable process heat could mitigate approximately 2.46–7.65 million tonnes of GHG emissions annually, depending on location and thermal-storage provision. Their findings show that emissions reductions may result not only from substituting materials but also from changing the energy systems used during production. Kishna et al. (2017) examined 105 alliances in the bio-plastics sector and demonstrated how collaboration can create legitimacy for sustainable technologies. Although their study does not directly measure textile emissions, it is relevant to the adoption of bio-based and cellulose-based materials. Partnerships among firms, researchers, and other organizations may support technological acceptance, market development, and wider sustainability transitions.

Overall, the literature shows that textile GHG emissions are shaped by the interaction of sectoral output, material composition, production processes, and energy structure. Nevertheless, limited research simultaneously compares apparel and home textiles, disaggregates material categories, and evaluates decoupling during 2019–2024. This study addresses that gap by integrating sectoral, material, and decoupling analysis.

1.3. Research gap and Rationale for the study

The textile industry has been well established as a major contributor of GHG emissions. While governments and firms are trying to adopt stricter climate policies, pollution monitoring, and sustainable targets, the need for evidence-based assessments of emission patterns and their underlying drivers remains. Existing studies mainly focus on specific production stages in correlation with pollution, offering a limited understanding of sector-wide emission dynamics and the relation of economic growth and environmental impacts. This study provides a

systematic assessment of GHG emissions across textile sectors and material categories, generating insights to support evidence-based policymaking, adoption of sustainable production practices, and long-term strategies for achieving a low-carbon textile industry, all of which support economic growth.

Research and data around GHG emissions in the textile industry certainly exist, but some important gaps remain. There is limited data available, and studies have been conducted that focus on differences in emissions with reference to natural, synthetic, and blended fibers despite their distinct environmental impacts, as most studies only focus on individual stages of the value chain, like manufacturing or apparel production, instead of a comprehensive sectoral analysis and comparison across the textile industry. In addition, with constantly evolving technologies, there have been recent changes in production patterns and sustainability initiatives between the years 2019-2024 which haven't been considered in emissions data. Also, there is limited application of decomposition techniques with decoupling analysis to distinguish the relative contributions of production growth, energy intensity, structural changes, and carbon intensity. Therefore, this research addresses an area where there is insufficient information to conclude whether economic growth in the textile sector has decoupled from GHG emissions.

2. Materials and methods

2.1. Research Aim and Objectives

This study aims to explore the change and drivers of GHG emissions in the textile sector from 2019 to 2024 and to analyze the economic–environmental decoupling within the sector, taking into account differences between the apparel and household textiles sectors.

The specific objectives are to:

- Examine the patterns in textile production and GHG emissions between 2019 and 2024 for total textiles, apparel and household textiles.
- Use regression analysis to estimate GHG emissions elasticity to the production in each sector.
- Evaluate relative and absolute decoupling by looking at carbon intensity and at output growth and emissions growth.
- Test if production is independent of temporal factors (measured by the year trend).

2.2. Research Hypotheses

Based on the literature and the conceptual framework of decoupling, the following hypotheses guide the analysis:

- **H1 (Total textiles):** Production has no linear association with total textile GHG emissions in the log–log model.
- **H2 (Apparel):** Apparel production has no linear association with apparel-related GHG emissions in the log–log model.
- **H3 (Household textiles):** Household-textile production has no linear association with household-textile GHG emissions in the log–log model.

2.3. Data

The data used in this study is global, at sectoral level, and secondary time-series data. The analysis is done for a period of 6 years (2019 to 2024). All of the data come from the Textile Exchange Climate Dashboard, which aggregates the industry-level indicators of production volume, GHG emissions, and other indicators for textiles, apparel, and household textiles.

2.4. Description of Variables

2.4.1. Dependent Variable

- **GHG emissions ($\ln(\text{GHG_emissions})$, $\ln(\text{GHG_emissions_apparel})$, $\ln(\text{GHG_emissions_HH})$):** GHG emissions are the total amount of greenhouse-gas emissions (in million tonnes of CO₂-equivalent) attributable to textile production, disaggregated by apparel production, household textile production, and the total. As a dependent variable due to the study to explain variations in environmental impact as a function of production and time. To aid interpretation of coefficients as elasticities and to minimize skewness in the data, natural logarithms are taken.

2.4.2. Independent Variables

- **Production ($\ln(\text{production})$, $\ln(\text{prod_apparel})$, $\ln(\text{prod_HH})$):** Production represents the index or physical volume of textile production for total textiles, apparel, and household textiles, respectively. It is added as the key explanatory variable to account for the scale effect of an economic activity's emissions. The percentage change in emissions for a 1% change in output can be estimated using log transformations.

- **Year:** A time-trend variable that is coded sequentially (e.g., year 2019 = 1, 2020 = 2, 2021 = 3, etc.) to capture temporal changes in emissions that are not accounted for by production, such as technological progress, policy interventions or energy mix changes. It examines the possibility of a decreasing trend in emissions with respect to output.

2.5. Methodology

The methodology includes descriptive trend analysis and inferential regression modelling to analyze the relationship between textile production and GHG emissions and the decoupling pattern.

- **Trend Analysis Using Trend Lines:** Time series plots are prepared for total textiles, apparel, and household textiles production and GHG emissions and carbon intensity (GHG emissions per unit of production) over the period 2019-2024 by using trend lines. A line of best fit (linear or polynomial) is added to each series to help visually determine the direction and magnitude of trend for each series. Initial evidence of relative or absolute decoupling lies in the differences between the slopes of the production and emissions trends. The first evidence for relative or absolute decoupling is provided by the difference in the trend in production and emissions slopes. Trends in carbon intensity are used as a measure of whether carbon emissions are decreasing over time.
- **Regression Analysis:** To quantify the production–emissions relationship, three separate log–log linear regression models are estimated:

$$\ln(\text{GHG_emissions_t}) = \alpha + \beta_1 \ln(\text{production_t}) + \beta_2 \text{Year_t} + \varepsilon_t$$

$$\ln(\text{GHG_emissions_apparel_t}) = \alpha + \beta_1 \ln(\text{prod_apparel_t}) + \beta_2 \text{Year_t} + \varepsilon_t$$

$$\ln(\text{GHG_emissions_HH_t}) = \alpha + \beta_1 \ln(\text{prod_HH_t}) + \beta_2 \text{Year_t} + \varepsilon_t$$

In both models, b_1 is the elasticity of emissions with respect to production. A value of $b_1 > 1$ would suggest no absolute decoupling, and $b_1 < 1$, would suggest relative decoupling. The parameter b_2 for Year represents any systematic time effects on emissions that are not explained by production. T-tests and p-values are used to interpret the statistical significance and 95% confidence intervals are attached to all coefficients. Model diagnostics consist of the tests for multicollinearity and the residual pattern; however, the length of the sample ($n = 6$) makes formal time-series diagnostics difficult.

This integrated approach allows for a systematic assessment of the effects of the textile growth on the environment as well as of the pathway of the textile sector to a low-carbon one.

3. Results

Figure 1: Trends in Total Emissions and Production from Textile Industry (2019-2024)
(million tonnes of CO₂-equivalent)

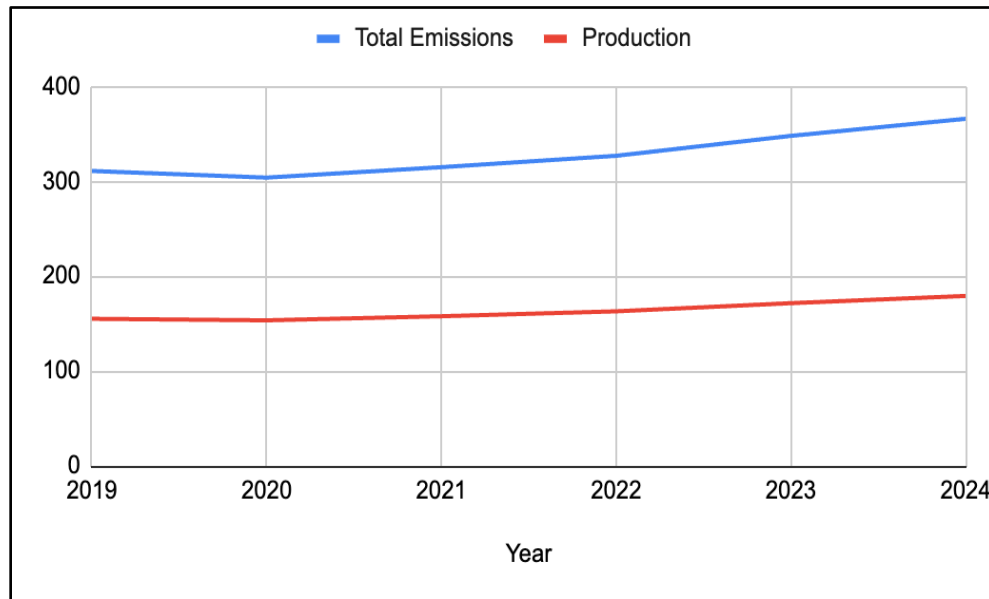
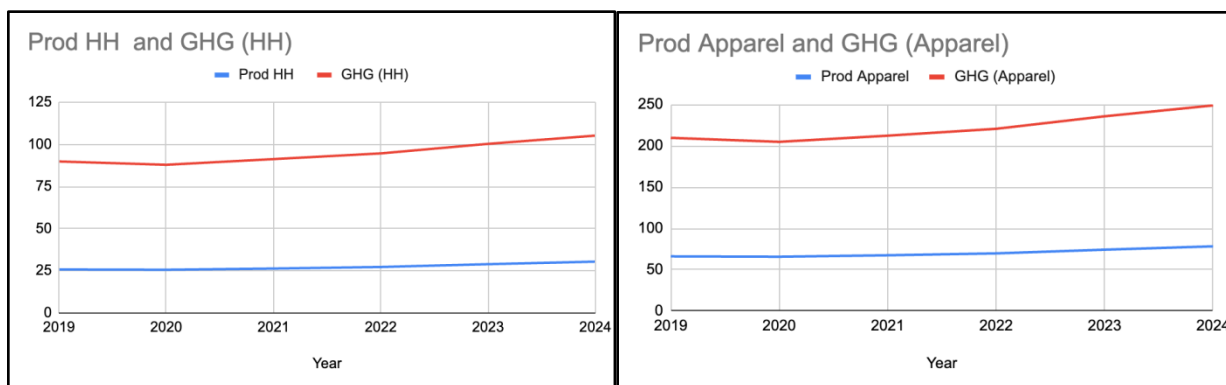


Figure 2: Trends in Total Emissions and Production from Textile Industry (2019-2024)
(million tonnes of CO₂-equivalent)

a) Household (HH)

b) Apparel



The graph above shows that household textiles, GHG emissions are showing a steeper increasing trend as compared to the flat trend of production. Similarly, the difference between production and apparel is that the GHG emissions produced by production of household textiles is below 100 and has gone up till 105, as can be inferred by the 2nd and 3rd graphs. However, apparel has

much higher almost double the emissions of GHG as compared to household but production is also double. Overall, the total emissions are increasing at a higher rate compared to production. For household production, the GHG emissions are increasing at a high rate, from 89 to 105.

Between 2019 and 2024, textile production increased steadily from 155.18 to 179.29, representing a growth of approximately 15.5%. During the same period, total GHG emissions increased from 311 to 366, an increase of nearly 17.7% . Although production and emissions followed similar upward trajectories, emissions increased at a slightly faster rate than production, indicating that improvements in production efficiency have not been sufficient to offset the environmental impact of expanding output.

Carbon intensity remained relatively stable, increasing only marginally from 2.00 to 2.04 which suggests only weak evidence of relative decoupling, as emissions continued to rise almost proportionally with production. The absence of a declining carbon intensity indicates that technological improvements and energy efficiency gains have not significantly reduced emissions per unit of output and cleaner fuels have been adopted.

Apparel production increased from 66.20 to 78.35 while associated emissions rose from 209.71 to 248.95, accounting for approximately 68% of total textile emissions throughout the study period. Household textiles contributed a considerably smaller share, with production increasing from 25.79 to 30.43 and emissions rising from 89.82 to 105.15, representing around 29% of total emissions. Although apparel generated almost twice the emissions of household textiles, this largely reflects its greater production volume rather than disproportionately higher emissions intensity.

Table 1: Regression results showing the relationship between emissions and production

Model 1: Dependent Variable: ln(GHG_emissions)				
Model	Unstandard. Coef. B	Std. Error	t	p
Constant	9.87	3.07	3.22	0.049
Year	-0.01	0	-3.28	0.046
ln(production)	1.33	0.05	26.55	<.001
Model 2: Dependent Variable: ln(GHG_emissions_apparel)				
Model	Unstandard. Coef. B	Std. Error	t	p
Constant	9.4	8.47	1.11	0.348

Year	0	0	-1.01	0.386
ln(prod_apparel)	1.19	0.12	10.06	0.002
Model 3: Dependent Variable: ln(GHG_emissions_HH)				
Model	Unstandard. Coef. B	Std. Error	t	p
Constant	7.09	9.7	0.73	0.517
Year	0	0.01	-0.61	0.588
ln(prod_HH)	1.08	0.14	7.95	0.004

The production elasticities for all the three are positive and significant, thus suggesting a strong correlation between an increase in production and increase in GHGs emissions. When it comes to total textiles, the stronger correlation is between textiles production and emissions ($B = 1.33$, $p < .001$). Moreover, for apparel, a 1% increase in production is associated with a 1.19% increase in emissions ($B = 1.19$, $p = .002$); and for household textiles, a 1% increase in production is associated with a 1.08% increase in emissions ($B = 1.08$, $p = .004$). Each elasticity is greater than 1, indicating that emissions grow at a higher rate than production, with no evidence of the decoupling of emissions from growth and suggesting a scale effect outweighs any efficiency or technological advancements claimed by the time trend. However, the Year coefficient, which captures the effect of time, is not strongly significant in the aggregate model ($B = -0.01$, $p = .046$), nor in the apparel or household-textile model ($p = .386$ and $.588$, respectively), suggesting that the effect of time is not very strong when the production volume is taken into account.

4. Discussion

The textile industry studied in this paper saw a moderate growth in production and a slightly higher rise in GHG emissions throughout 2019 - 2024. In contrast, this suggests there was weak relative decoupling, but no absolute decoupling, because emissions were even increasing as output was increasing. This trend aligns with patterns seen across the industry, where overall decreases in the environmental intensity of production have been insufficient to counteract rising demand for textiles and materials due to increased consumption. (European Environment Agency, 2025; Wiedmann et al., 2020).

Recent industry assessments likewise indicate that emissions associated with textile raw materials and apparel production remain substantial and continue to be influenced by increasing production volumes. Textile Exchange identifies raw-material production as a major source of industry emissions, while recent sector assessments report that apparel-related emissions

increased between 2023 and 2024 rather than following a sustained downward trajectory (Textile Exchange, 2024; Apparel Impact Institute, 2026).

Within the present results, apparel accounts for the largest share of emissions, reflecting its high production volumes and energy-intensive processing requirements. This finding is consistent with estimates for EU textile consumption, where clothing accounted for approximately half of the emissions associated with clothing, footwear, and household textiles consumed in 2020. The same assessment attributed a further 30% to household and other textiles and 20% to footwear, although these proportions refer specifically to EU consumption and should not be generalized directly to the global textile industry (European Environment Agency, 2022).

Household textiles account for a smaller share of total emissions in the present dataset but show a comparatively steep increase relative to production growth. This may indicate more energy- or material-intensive processing, greater dependence on thermal energy, or slower adoption of low-carbon technologies in this subsector. More recent European estimates show that clothing, footwear, and household textiles together generated 159 million tonnes of CO₂-equivalent emissions across the supply chain of products consumed by EU households in 2022, demonstrating the continuing scale of textile-related climate impacts (European Environment Agency, 2025).

The regression results further support the conclusion that output growth is the principal driver of emissions. Positive and statistically significant production coefficients, together with elasticity estimates greater than one, suggest that emissions increased more than proportionately with production. This interpretation is consistent with decomposition-based approaches in which the activity effect associated with expanding production can outweigh reductions from improvements in energy intensity and technological efficiency (Intergovernmental Panel on Climate Change, 2022; European Environment Agency, 2025).

The near-constant carbon intensity and statistically insignificant year trend in the present model imply that substantial technology- or policy-driven decarbonization did not occur during the study period. This interpretation is also consistent with evidence that industrial emissions remain closely associated with fossil-fuel combustion, electricity use, and process heat, particularly where renewable-energy deployment and electrification remain limited (Intergovernmental Panel on Climate Change, 2022).

Several structural factors may explain the observed increase. Fast-fashion business models and expanding global demand have increased production volumes, while wet-processing activities such as dyeing and finishing remain energy- and heat-intensive. The adoption of high-efficiency machinery, waste-heat recovery, renewable electricity, and electrified thermal systems has also

been uneven because of capital constraints, fragmented supply chains, and differences in technological capacity across production regions (European Environment Agency, 2022; International Energy Agency, 2020).

At the same time, incremental mitigation measures may have moderated emissions growth at the margin. These include improvements in energy efficiency, a gradual increase in the use of preferred fibres, corporate climate commitments, and industry roadmaps for net-zero apparel. However, available assessments indicate that these measures have not yet been implemented at a sufficient scale to offset the emissions effects of expanding fibre and apparel production (Textile Exchange, 2024; Apparel Impact Institute, 2026).

Overall, the empirical evidence, rising emissions, faster emissions growth than production, stable carbon intensity, apparel-sector dominance, and the absence of a significant time effect, suggests that the textile industry remains in an early stage of structural transition. Production expansion has not yet been offset by sufficiently rapid decarbonization, highlighting the need for accelerated investment in renewable energy, process efficiency, electrification, waste-heat recovery, and lower-impact materials if genuine absolute decoupling is to be achieved (Intergovernmental Panel on Climate Change, 2022; European Environment Agency, 2025).

5. Conclusion

This research delivers a sectoral and material account of greenhouse-gas (GHG) emissions in the textile industry for the period 2019-2024, including the trends in textiles production, the carbon intensity and regression-based elasticity estimates. The main conclusion is that, in absolute terms, textile production increased by roughly 15.5% and GHG emissions increased by around 17.7%, suggesting that GHG emissions increased at a slightly higher rate than production. The coefficient of carbon intensity was essentially unchanged, increasing from 2.00 to 2.04, and indicating only weak relative decoupling but no absolute decoupling. Apparel makes up approximately 68% of total textile emissions and household textiles approximately 29% of total emissions. While the emissions from apparel are nearly double those from household textiles, these are mainly due to the volume of clothing produced and not significantly higher emissions intensity per unit of apparel.

The patterns are confirmed by regression results. Results indicate positive and statistically significant production elasticities in all specifications (1.33 total textiles, 1.19 apparel and 1.08 household textiles). Each elasticity is greater than 1, which suggests that there are scale effects, and that gains in efficiency or technology development over the time trend have not compensated for the environmental consequences of growing output. The year coefficient is not very

significant in the aggregate model and is not significant in the sectoral models, indicating that once production is taken into account the impact of time (policies, technology, etc.) is small.

These results confirm other studies that have reported raw-material production, wet processing (energy use), and process heat (fossil-fuel use) as important emission sources within the textile industry. They also support recent industry evaluations that indicate emissions from apparel activities are not consistently declining and that emissions at the raw material stages are still large sources of industry emissions. The sector's constant carbon intensity, and the absence of a significant time trend, suggest that the sector is still at a nascent stage of structural change with incremental gains in energy efficiency and fibre types not yet being realised at a pace that would allow true decoupling.

In general, the evidence indicates that maintaining the current production systems and energy mixes will lead to increased emissions as production grows. To achieve absolute decoupling will not only require increased rates of new renewable energy, but also try to electrify thermal processes, utilise waste heat, and expand the use of low impact materials with a coordinated push from industry and policy. If these measures are not taken, the growth in the textile sector will probably continue to be inconsistent with the long-term climate targets.

6. Policy recommendations

Policy makers should emphasize the need for mandatory reporting with a new granular level for emissions along the textile value chain, by textile product type and household textile material. Focus incentives and subsidies on renewable electricity, process heat (electrified), and waste-heat recovery (spinning, weaving, dyeing, and finishing). Low carbon and circular textile value chains can be created through public procurement and through extended producer responsibility (EPR) schemes; and costs of emissions can be internalised through carbon pricing or sectoral benchmarks. Research and development on preferred fibres, closed loop systems, and bio-based materials should be accompanied by transparent protection of the land and water and of the chemicals used. Lastly, international coordination on standards and finance can facilitate shaping global supply chains to meet national climate targets.

7. Limitations

The analysis is based on aggregated information for sectors and a rather short time-series (2019–2024), which does not allow for longer-term technological changes and/or policy effects. No disaggregation of emissions by specific production stages, energy sources and detailed fibre mixes, limiting causal interpretation. Production and time are the only factors that are controlled for in the regression models, not a number of other factors that could influence it such as energy prices, trading patterns and firm heterogeneity.

References

Acme Mills. (2026, July 23). *How the textile industry shapes global manufacturing*. <https://acmemills.com/industry-news-blog/what-is-textile-industry-definition-and-meaning/>

Al-Maharma, A. Y., Patil, S. P., & Markert, B. (2022). Environmental impact analysis of plant fibers and their composites relative to their synthetic counterparts based on life cycle assessment approach. In *Elsevier eBooks* (pp. 741–781). <https://doi.org/10.1016/B978-0-12-824543-9.00022-0>

Apparel Impact Institute. (2026, September 1). *Taking stock of progress against the roadmap to net zero 2026*. <https://apparelimpact.org/resources/taking-stock-2026/>

Assuncao, M. (2026, August 5). *The impact of the textile industry: Assessment and sustainable solutions*. Decarbo'Solution. <https://decarbosolution.ai/en/limpact-de-lindustrie-du-textile-bilan-et-solution-durable/>

Bajaj Finance. (n.d.). *Textile industry in India: Types, importance, growth, and history*. <https://www.bajajfinserv.in/textile-industry-in-india>

Baker Tilly International. (2026, January 20). *The economic consequences of climate change*. Baker Tilly. <https://www.bakertilly.global/insights/the-economic-consequences-of-climate-change>

Bhatti, U. A., Bhatti, U. A., Bhatti, M. A., Tang, H., Syam, Awwad, E. M., Sharaf, M., & Ghadi, Y. Y. (2023). Global production patterns: Understanding the relationship between greenhouse gas emissions, agriculture greening and climate variability. *Environmental Research*, 245, 118049. <https://doi.org/10.1016/j.envres.2023.118049>

Buy home furnishing and home textile at IKEA. (n.d.). IKEA. <https://www.ikea.com/in/en/cat/textiles-tl001/>

European Environment Agency. (2022). *Textiles and the environment: The role of design in Europe's circular economy*. European Topic Centre on Circular Economy and Resource Use. <https://www.eionet.europa.eu/etcs/etc-ce/products/etc-ce-products/etc-ce-report-2-2022-textiles-and-the-environment-the-role-of-design-in-europes-circular-economy/>

European Environment Agency. (2025, March 26). *Circularity of the EU textiles value chain in numbers*. <https://www.eea.europa.eu/en/analysis/publications/circularity-of-the-eu-textiles-value-chain-in-numbers>

European Environment Agency. (n.d.). *Indicators: Analysis and data*. <https://www.eea.europa.eu/en/analysis/indicators>

Fabric fabric. (n.d.). *7 key advantages of natural fibers for eco-friendly projects*. <https://fabric-fabric.com/blog/advantages-of-natural-fibers-eco-friendly-projects>

Filho, W. L., Dinis, M. A. P., Liakh, O., Paço, A., Dennis, K., Shollo, F., & Sidsaph, H. (2024). Reducing the carbon footprint of the textile sector: An overview of impacts and solutions. *Textile Research Journal*, 94(15–16), 1798–1814. <https://doi.org/10.1177/00405175241236971>

GeeksforGeeks. (2024, August 5). *Types of synthetic fibers*. <https://www.geeksforgeeks.org/chemistry/types-of-synthetic-fibers/>

Hong, Y., Ma, L., Kang, S., & Zhang, G. (2025). Decoupling carbon emissions from economic growth in China's textile industry: A decomposition of driving factors. *Frontiers in Environmental Science*, 13. <https://doi.org/10.3389/fenvs.2025.1587498>

Imran, S., Mujtaba, M., Zafar, M. M., Hussain, A., Mehmood, A., Farwa, U. E., Korakianitis, T., Kalam, M., Fayaz, H., & Saleel, C. A. (2023). Assessing the potential of GHG emissions for the textile sector: A baseline study. *Heliyon*, 9(11), e22404. <https://doi.org/10.1016/j.heliyon.2023.e22404>

International Energy Agency. (2020). *Energy technology perspectives 2020*. OECD Publishing. <https://www.iea.org/reports/energy-technology-perspectives-2020>

Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Mitigation of climate change*. Cambridge University Press. <https://www.ipcc.ch/report/ar6/wg3/>

Jiménez, R., Baker, L., Deda, P., Annovazzi-Jakab, L., Steierer, F., Heller, B., Giacobelli, C., Arthur, R., Jones, U., Morris-Trainor, Z., Ernst, N., Musembi, A., Kozlik, J., De Pourtales, V., Simonett, O., & Novikov, V. (2024). *Fashion & land: Unravelling the environmental impact of fibres*. UNCCD. https://www.unccd.int/sites/default/files/2024-12/UNCCD-Fashion%26LAND-FINAL%20online%20publication_final_single%20pages.pdf

Kishna, M., Niesten, E., Negro, S., & Hekkert, M. P. (2016). The role of alliances in creating legitimacy of sustainable technologies: A study on the field of bio-plastics. *Journal of Cleaner Production*, 155, 7–16. <https://doi.org/10.1016/j.jclepro.2016.06.089>

Rawshot.ai. (2026, July 26). *Carbon footprint in the textile industry*. <https://rawshot.ai/statistic/carbon-footprint-in-the-textile-industry>

Sancheti, M. (2025, August 4). *Textile sector in India: PM Modi highlights its role in economic growth and empowerment*. Corpseed. <https://www.corpseed.com/knowledge-centre/pm-modi-vision-how-india-textile-sector-is-weaving-economic-growth>

Sharma, A. K., Sharma, C., Mullick, S. C., & Kandpal, T. C. (2017). GHG mitigation potential of solar industrial process heating in producing cotton-based textiles in India. <https://agris.fao.org/search/en/providers/122535/records/65dfdfa0f3e94b9e5dd2573>

Sovbetov, I. (2025). Carbon footprint embodied in global fiber trades. *Journal of Natural Fibers*, 22(1). <https://doi.org/10.1080/15440478.2025.2503970>

Stewart, Z. (2025, March 27). *Viscose, rayon, modal, lyocell, cupro: Decoding man-made textiles*. EarthDay.org. <https://www.earthday.org/viscose-rayon-modal-lyocell-crupe-decoding-man-made-textiles/>

Textile Exchange. (2024). *Reimagining growth: A landscape analysis of the textile fibre and materials industry*. <https://textileexchange.org/app/uploads/2024/12/Reimagining-Growth-Landscape-Analysis.pdf>

United Nations. (n.d.). *What is climate change?* <https://www.un.org/en/climatechange/what-is-climate-change>

United Nations Environment Programme. (2011, February 22). *Decoupling: Natural resource use and environmental impacts from economic growth*. <https://www.unep.org/resources/report/decoupling-natural-resource-use-and-environmental-impacts-economic-growth>

Wang, L., Li, Y., & He, W. (2017). The energy footprint of China's textile industry: Perspectives from decoupling and decomposition analysis. *Energies*, 10(10), 1461. <https://doi.org/10.3390/en10101461>

Wiedmann, T., Lenzen, M., Keyßer, L. T., & Steinberger, J. K. (2020). Scientists' warning on affluence. *Nature Communications*, 11, Article 3107. <https://doi.org/10.1038/s41467-020-16941-y>